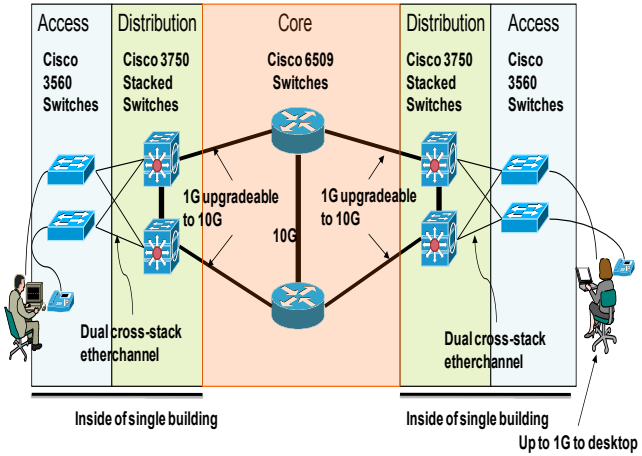
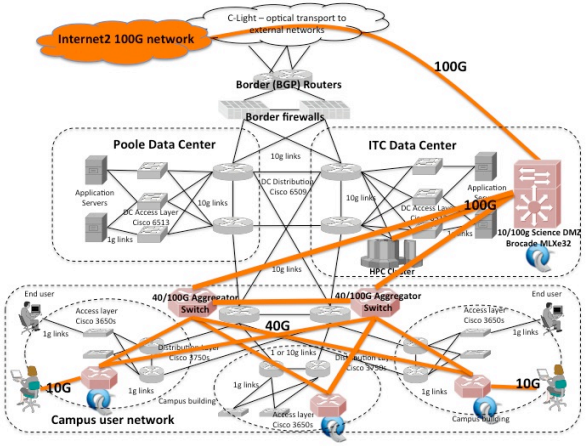
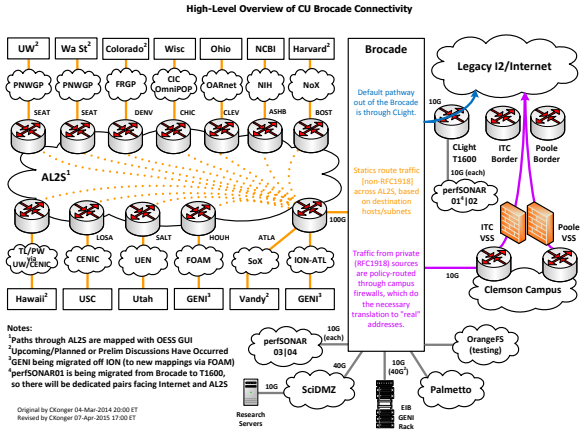
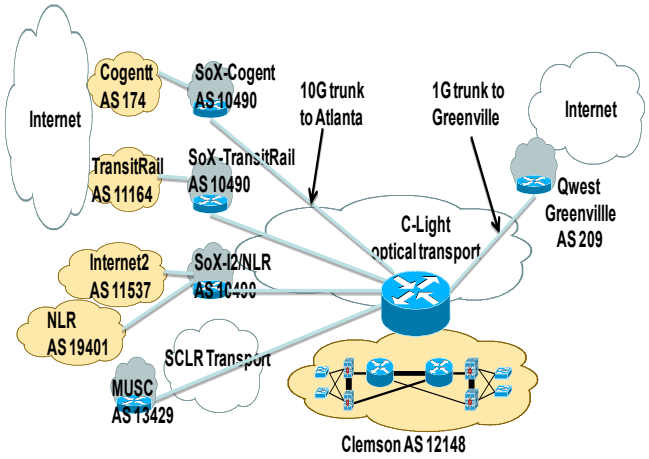
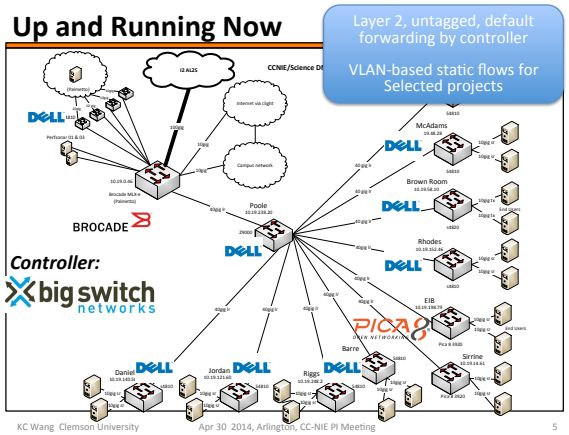
2009 … 2012 … 2015

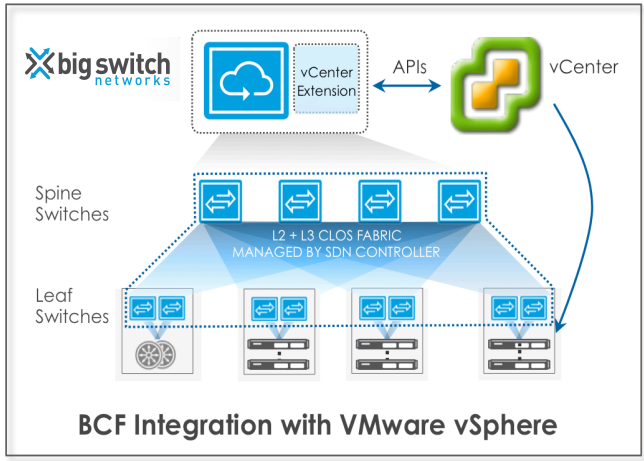












SDN invisible to IT

- GENI VLANs to lab
- Data analysis network

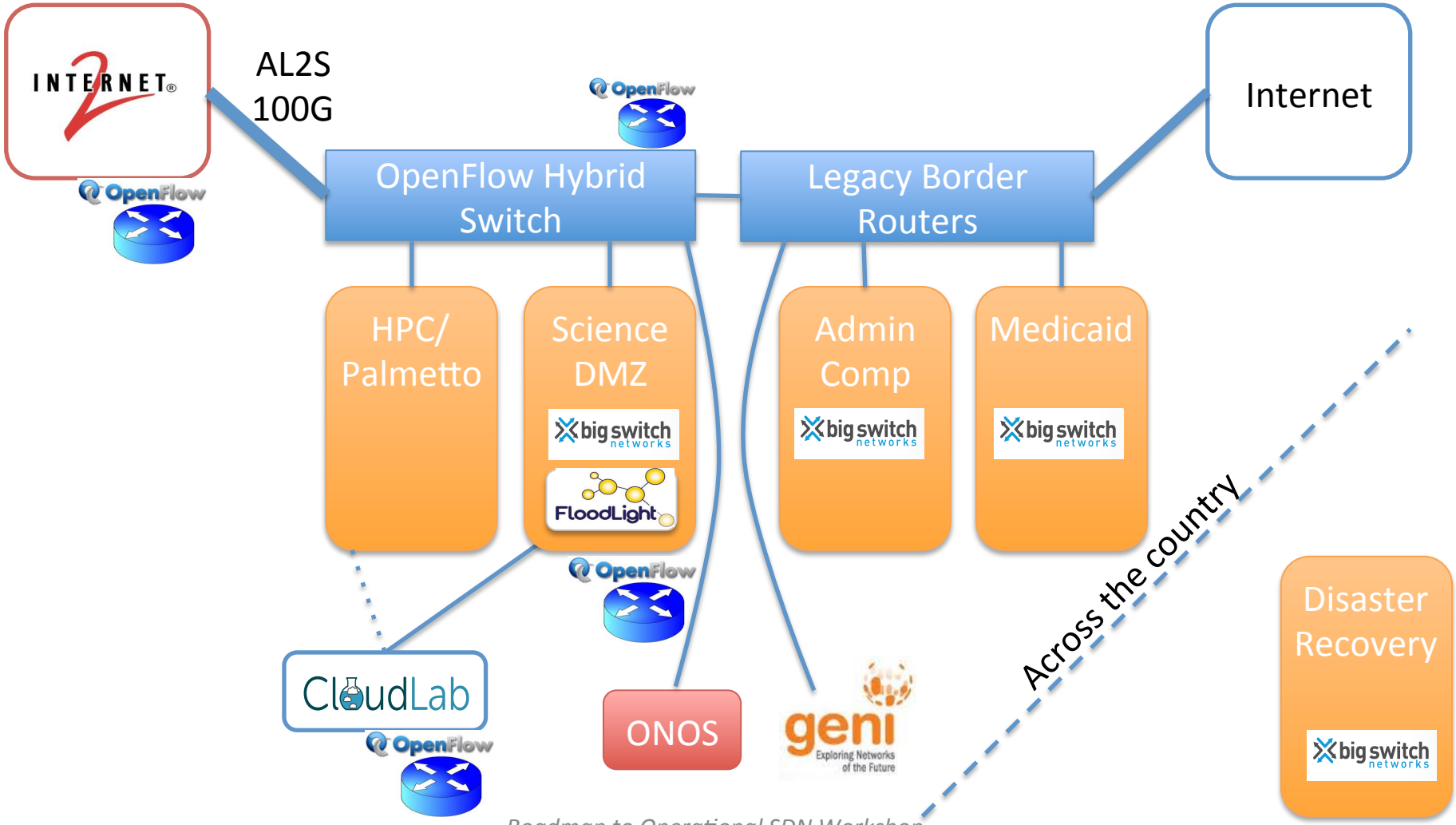
SDN trial by IT

- 20 buildings science DMZ, lots of issues, sparse p2p research traffic, production grade service

SDN in production by IT

- New data center pods
- New strategies for networking, security, disaster recovery

SDN Landscape - View from Clemson



Campus IT Operation

- SDN domains in and around campus
  - Each is an "autonomous" system with own authority, architecture, resource, constraints
  - Operation focuses on design of network boundaries
    - Not just SDNs
    - Design around resources present at boundary
      - VLANs, e.g., as used by GENI, I2 AL2S, CloudLab
      - SDN-enabled flow space, e.g., I2 FlowSpaceFirewall
- Implications on monitoring
- New demands driven by applications
  - Beyond network connectivity
    - Compute, storage, security, load-balancing, firewall, …

Campus IT Infrastructure

- Cloud Orchestration
  - VmWare, OpenStack
  - CloudLab
- VDI
  - OpenStack + Neutron networking
- Disaster Recovery
  - Big Switch BCF + BigTap pods
- SDN-ready Wi-Fi
- Identity management
  - Fedushare
  - Application/attribute based access control

Wants in a SDN

- Basic feature parity
  - Campus
    - Connectivity, IAM, Scalability
  - Data Center
    - Multi-tenancy, scalability, HA
    - Flood Protection, Disaster recovery design
- Simplification + backward compatibility
  - Simplification is great – e.g., manage/monitor one "big switch" instead of 100s of
  - Backward compatibility is crucial - legacy "interfaces" is important for operation continuity – such as SNMP MIBs
- New Features
  - Great, one at a time, not the biggest rush
- Managed/manageable programmability (e.g., multiple independent SDN instances)

Wants for "Things Out There"

- Resources over multi-domain networks
  - Software Defined Exchange (SDX)
- Current SDX examples have demonstrated
  - Finer-grain-than-BGP pairing
  - Inter-domain resource stitching
  - Inter-domain policy handling
- Research needed on resource abstraction, a new, possibly composite view
  - Abstraction, policy, economics
- Multi-domain agreement
  - Model, solution, resiliency
- Identity and Access Management